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Trematodes of the Genus *Orientocreadium* (Digenea: Orientocreadiidae) from Freshwater Fishes of Japan

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ABSTRACT—From Japanese freshwater fishes, *Orientocreadium chaenogobii* sp. n. and *O. pseudobagri* Yamaguti, 1934 (Orientocreadiidae), are described and illustrated. Data on their hosts, geographical distribution and life cycles are provided. The new species from the rectum of *Chaenogobius laevis* (type host) and *Ch. urotaenia* (the freshwater type) (Gobiidae) of Hokkaido most closely resembles *O. pseudobagri* and *O. siluri* (Bykhovskiĭ et Dubinina, 1954) Yamaguti, 1958, but differs from them in the oral sucker being smaller than the ventral, the vitellaria commencing at the ventral sucker level and other morphological features.

INTRODUCTION

This paper, the sixth in a series on the digenetic trematodes of the Japanese freshwater fishes, deals with two species, including a new one, of the genus *Orientocreadium* Tubangui, 1931 [1] (Orientocreadiidae).

MATERIALS AND METHODS

The materials and methods have been described in the first paper [2].

RESULTS AND DISCUSSION

Family **Orientocreadiidae** Yamaguti, 1958

Orientocreadiinae Yamaguti, 1958 [3], p. 171 (type genus, *Orientocreadium* Tubangui, 1931 [1]).
Orientocreadiidae: Skrjabin and Koval', 1960 [4], p. 17; 1963 [5], p. 84.

Diagnosis. Body elongate to fusiform, spinose or reportedly smooth, may or may not have unicellular glands [6] in forebody. Oral sucker simple, subterminal. Prepharynx distinct. Pharynx comparatively large. Esophagus usually short, rarely long, bifurcating in front of ventral sucker; intestinal ceca terminating at near posterior extremity of body. Ventral sucker in anterior half of body. Testes two, entire or lobate, median, tandem or oblique, in posterior half of body. Cirrus pouch clavate, enclosing internal seminal vesicle, prostatic complex and cirrus, usually extending posteriorly to ventral sucker; cirrus spined internally or not; external seminal vesicle present. Genital atrium shallow. Genital pore median, immediately in front of ventral sucker. Ovary entire or trilobed, almost median, between ventral sucker and anterior testis. No seminal receptacle. Laurer's canal present. Ootype complex usually postovarian. Uterus serving as seminal receptacle in proximal coils, extending backward as far as, or to near, posterior extremity of body, overreaching ceca laterally; metraterm well developed, spined internally or not. Eggs operculate, small, numerous, segmented, fully embryonated or not. Vitellaria in lateral fields of hindbody, continuous or not, usually reaching to posterior extremity of body, may or may not unite to form a lattice work in younger worms. Excretory vesicle tubular or Y-shaped, reaching to posterior testis. Intestinal parasites of freshwater fishes and reptiles.

Miracidia nonoculate, bearing a pair of flame cells; epidermal cell formula 3, 3. Armatae cercariae produced in daughter sporocysts in *Lymnaea* snails; flame cell formula 2 [(3+3+3)+(3+3+3)]

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=36. Metacercariae encysting in aquatic animals such as mollusks, a parasitic olygochaete and fishes and even in their daughter sporocysts.

Discussion. This diagnosis is based on Skrjabin and Koval' [5], Yamaguti [7], Tang and Lin [8], Besprozvannykh [9] and the present study.

All the available descriptions of the existing genera and species, particularly those from India, in the family were based on relatively poor material. Dayal [10, 11] described the presence of a small seminal receptacle in his new species, *Neoganaga barabankiae* and *N. secunda.* However, it is suggested that what he called the seminal receptacle is not a true one but a chamber made of the distal portion of the oviduct and the proximal portion of Laurer's canal (see this paper). Tang and Lin [8, fig. 2] described Laurer's canal and its expanded proximal portion as filled with sperm. Fischthal and Kuntz [6], considering the shape (I- or Y-shaped) of the excretory vesicle to have a generic significance, recognized two genera as valid (but either in the family Plagiorchiidae Lühe, 1901, or partly in it and partly in the family Brachycoeliidae Looss, 1899): *Orientocreadium* Tubangui, 1931 [1] (syn., *Paratormopsolus* Bykhovskiĭ et Dubinina, 1954 [12]), with an I-shaped excretory vesicle; and *Ganada* Chatterji, 1933 [13] (syn., *Neoganada* Dayal, 1938 [10], *Nizamia* Dayal, 1938 [14], *Ganadotrema* Dayal, 1949 [11], *Macrotrema* Gupta, 1951 [15]), with a Y-shaped excretory vesicle. Tang and Lin [8] and Besprozvannykh [9] described and figured a distinctly Y-shaped excretory vesicle in the cercarial stages of *O. batrachoides* Tubangui, 1931 [1], and *O. pseudobagri* Yamaguti, 1934 [16], respectively. In the adult stages of both species, on the contrary, the excretory vesicle is I-shaped [1, 6, 16, 17]. This discrepancy remains to be explained. In the present study I failed to definitely determine the shape of the excretory vesicle in *O. pseudobagri.* All the described genera and species need further studies of their morphology and life cycles. Yamaguti [7] synonymized all the six other genera with *Orientocreadium,* but I follow Fischthal and Kuntz [6] for the time being.

The family occurs in Japan, China, the Philippines, India, Russia, Poland, Czechoslovakia, the Sudan, Egypt and the Rhodesias [7, 18–20].

Genus *Orientocreadium* Tubangui, 1931

Orientocreadium Tubangui, 1931 [1], pp. 417–418 (type species, *O. batrachoides* Tubangui, 1931).

Paratormopsolus Bykhovskiĭ et Dubinina, 1954 [12], p. 789 (type species, *P. siluri* Bykhovskiĭ et Dubinina, 1954).

Diagnosis. Orientocreadiidae. Esophagus short. Testes entire. Ovary entire. Excretory vesicle I-shaped.

Discussion. The following are Japanese species.

Orientocreadium chaenogobii sp. n. (Figs. 1–3)

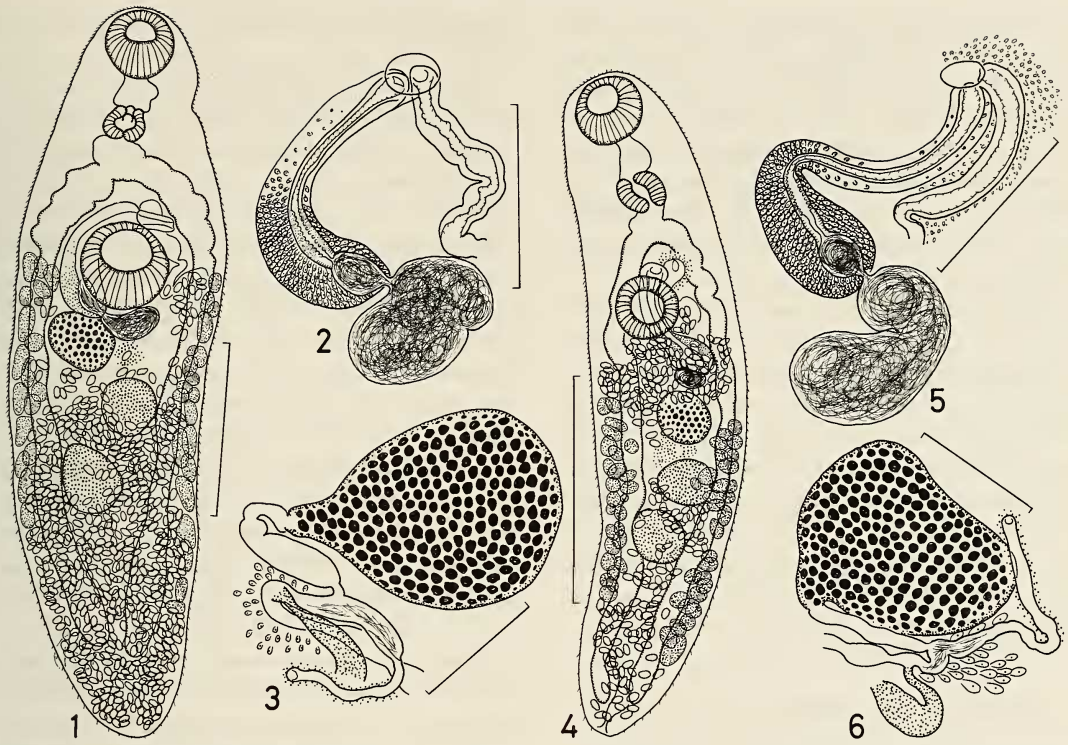
Material examined. 1) Lot 1. Twenty-two gravid whole-mounts (NSMT-Pl 3636–3637) from the rectum of *Chaenogobius laevis* (Gobiidae) from Lake Toro near Kushiro, Hokkaido, on October 10, 1981, and July 22, 1984. The specimens (3637) were collected by Nagasawa.

2) Lot 2. One immature and 3 gravid whole-mounts (NSMT-Pl 3639) from the rectum of *Ch. laevis* from the Chitose River at Ebetsu, Hokkaido, on August 2, 1984.

3) Lot 3. Fifty-eight gravid whole-mounts (NSMT-Pl 3064 and 3638) from the rectum of *Ch. urotaenia* (=*Ch. annularis*) (the freshwater type) from Lake Toro on June 28, 1984.

Description. Ten gravid whole-mounts of lot 1 measured (Figs. 1–3). Body fusiform, 0.99–2.13 by 0.46–0.63; forebody 0.43–0.71, 30–44% of total body length. Tegumental spines covering all over body though becoming sparse posteriorly. Unicellular glands present in forebody anterior to cecal arch; their ducts uncertain. Oral sucker 0.12–0.20 by 0.13–0.20. Prepharynx thick, 0.05–0.09 long. Pharynx 0.06–0.11 by 0.09–0.12, with 4 anterior muscular protuberances. Esophagus short, 0.03–0.08 long, bifurcating about midway between two suckers; intestinal ceca thick, slightly sinuous, terminating near posterior end of body. Ventral sucker 0.14–0.24 by 0.15–0.26; sucker width ratio 1: 1.20–1.50.

Testes oblique, entire, usually contiguous, rarely separated by uterus, 0.08–0.27 by 0.12–0.24, preequatorial in hindbody. Cirrus pouch club-shaped, curved, 0.20–0.35 by 0.06–0.09, extending posteriorly between ventral sucker and ovary; internal



Figs. 1–3. *Orientocreadium chaenogobii* sp. n. 1: Adult worm, holotype (lot 1), ventral view. 2: Terminal genitalia, paratype (lot 1), ventral view. 3: Ovarian complex, paratype (lot 1), dorsal view.
Figs. 4–6. *O. pseudobagri.* 4: Adult worm, holotype (lot 1), ventral view. 5: Terminal genitalia in lot 2, ventral view. 6: Ovarian complex in lot 3, dorsal view.
(Scale bars: 0.5 mm in Figs. 1 and 4; 0.2 mm in Figs. 2–3 and 5–6.)

seminal vesicle oval, small; pars prostatica oblong, with a well-developed sphincter at posterior end; prostatic cells numerous, densely surrounding pars prostatica and internal seminal vesicle; cirrus long, slender, spined internally, slightly protrusible; external seminal vesicle saccular, voluminous, behind ventral sucker. Genital atrium wide, shallow. Genital pore median, in front of ventral sucker. Ovary globular, to right of median line, closely facing ventral sucker across cirrus pouch, 0.08–0.19 by 0.14–0.20. Laurer's canal running posteriorly, opening dorsally about anterior border of anterior testis; its proximal portion and distal portion of oviduct making an expanded chamber, sometimes storing a small number of sperm in it. Ootype complex postovarian. Uterus occupying all available space of hindbody; metraterm well developed, shorter than cirrus pouch, spined internally. Eggs numerous, operculate, not fully embryonated though segmented, 32–38 by 18–22 μm. Vitellaria variable in shape and size, distributed continuously on ventral and lateral sides of ceca from ventral sucker level to short distance in front of cecal termination (or about halfway between posterior testis and posterior end of body), separated there. Excretory vesicle reaching to posterior testis, probably I-shaped; excretory pore terminal.

Hosts: *Chaenogobius laevis* (type host) and *Ch. urotaenia* (the freshwater type) (Gobiidae).

Site of infection: Rectum.

Localities: Lake Toro (type locality) and the Chitose River, Hokkaido.

Specimens: Holotype, NSMT-Pl 3636; 83 paratypes, NSMT-Pl 3064 and 3636–3639.

Discussion. This new species, *Orientocreadium chaenogobii* sp. n., most closely resembles *O. pseudobagri* Yamaguti, 1934 (see below), and *O.*

siluri (Bykhovskiĭ et Dubinina, 1954 [12]) Yamaguti, 1958 [3], but differs from them in the oral sucker being smaller than the ventral (the sucker width ratio being 1: 1.20–1.50), the diagonal testes being located usually contiguous and pre-equatorial in the hindbody, the submedian ovary more closely facing the ventral sucker, Laurer's canal running posteriorly, and the vitellaria commencing at the ventral sucker level.

There is a gravid whole-mount (NSMT-Pl 3640) of the new species which Nagasawa obtained from "the intestine of *Moroco percnurus sachalinensis*" (Cyprinidae) from Lake Toro on August 8, 1981. This specimen was not used for the above description because the records of its host and site of infection on its label may possibly be erroneous.

The species parasitizes *Chaenogobius laevis* and *Ch. urotaenia* (the freshwater type) and possibly *Moroco percnurus sachalinensis* in Hokkaido, Japan [this paper]. It life cycle in unknown.

Orientocreadium pseudobagri Yamaguti, 1934 (Figs. 4–6)

Orientocreadium pseudobagri Yamaguti, 1934 [16], pp. 334–336, fig. 39.

Macroderoides asiaticus Belous in Skrjabin and Antipin, 1958 [21], pp. 519–525, fig. 149.

Material examined. 1) Lot 1. Four gravid whole-mounts (holotype and paratypes) (MPM Coll. No. 22290) of *Orientocreadium pseudobagri* of Yamaguti [16] from the intestine of [the gigi, *Pelteobagrus nudiceps*] (Bagridae) from Lake Biwa, Shiga Prefecture, on July 15, 1927. The two paratypes lack the anterior or the posterior part of the body. Yamaguti recorded the host as "*Pseudobagrus aurantiacus.*" The Japanese name for the fish with this scientific name is the "gibachi." The label says that the type series was found in the "gigi", or *P. nudiceps,* from Lake Biwa, and moreover the "gibachi" does not inhabit the lake.

2) Lot 2. Five gravid whole-mounts (NSMT-Pl 3633–3634) from the intestine of *P. nudiceps* from Lake Biwa at Onoe on May 4, 1979, and June 3, 1980. The specimens (3633) were collected by Nagasawa.

3) Lot. 3. One gravid whole-mount (NSMT-Pl 3635) from the intestine of *Silurus lithophilus* (Siluridae) from Lake Biwa at Onoe on June 3, 1980.

Description. 1) For the original description and figure for *O. pseudobagri,* see Yamaguti [16].

From lot 1, the holotype and paratype measured (Fig. 4). Body elongate, 1.18–1.50 by 0.22–0.34, broadest at about ovarian level; forebody 0.47–0.55, 37–40% of total body length. Tegumental spines present all over body though becoming sparse posteriorly. Unicellular glands present in region anterior to cecal arch in forebody; their ducts not worked out. Oral sucker 0.09–0.14 by 0.11–0.16. Prepharynx thick, 0.08–0.09 long. Pharynx 0.07–0.09 in diameter, with 4 anterior muscular protuberances. Esophagus short, 0.03–0.04 long, bifurcating at posterior third of forebody; intestinal ceca somewhat sinuous, reaching to near posterior end of body. Ventral sucker usually smaller than oral, 0.08–0.14 by 0.12–0.13; sucker width ratio 1: 0.85–1.07.

Testes subglobular, tandem, usually separated by uterus, in middle third of hindbody, 0.07–0.09 by 0.10–0.12. Cirrus pouch clavate, curved, 0.16–0.26 by 0.05–0.06, extending posterior to ventral sucker; internal seminal vesicle oval, small; pars prostatica oblong, with a well-developed sphincter at its posterior end; prostatic cells numerous, densely surrounding pars prostatica and internal seminal vesicle; cirrus long, slender, spined internally, slightly protrusible; external seminal vesicle saccular, voluminous, straight or curved, usually reaching to ovary. Genital atrium fairly wide, shallow. Genital pore median, in front of ventral sucker. Ovary spherical, pretesticular, almost median, standing fairly apart from ventral sucker, 0.08–0.12 in diameter. Laurer's canal present. Ootype complex between ovary and anterior testis. Uterus extending medianly to posterior end of body, coiled preovarian; metraterm well developed, shorter than cirrus pouch, spined internally, surrounded by gland cells. Eggs numerous, operculate, 30–32 by 16–20 μm (collapsed). Vitelline follicles variable in shape and size, extending continuously on ventral and lateral sides of ceca from ovarian level to some distance in front of cecal termination (or about halfway between posterior testis and posterior end of body), separated there. Excretory vesicle reaching to posterior

testis; its shape not definitely determined (probably I-shaped); excretory pore terminal.

2) From lots 2–3, 5 gravid whole-mounts measured (Figs. 5–6). Body 1.10–2.84 by 0.23–0.55; forebody 0.43–0.79, 28–39% of total body length. Oral sucker 0.09–0.17 by 0.10–0.19. Prepharynx 0.05–0.09 long. Pharynx 0.08–0.12 by 0.05–0.12. Esophagus 0.04–0.10 long. Ventral sucker usually smaller than oral, 0.09–0.15 by 0.11–0.18; sucker width ratio 0.82–1.00. Testes 0.06–0.28 by 0.07–0.30. Cirrus pouch 0.16–0.40 by 0.04–0.12. Ovary 0.08–0.16 by 0.09–0.20. Laurer's canal running anteriorly, opening dorsally at ovarian level; its proximal portion and distal portion of oviduct making an expanded chamber, sometimes containing a small number of sperm. Eggs not fully embryonated though segmented, 30–44 by 18–22 μm. Vitellaria sometimes interrupted at testicular levels and confluent posteriorly. Other features similar to those of lot 1.

Discussion. The present study proposes a slight emendation of the original description for this species by Yamaguti [16], as follows: tegumental spines covering all over body though becoming sparse posteriorly; unicellular glands present in forebody; pharynx with 4 anterior muscular protuberances; internal seminal vesicle oval, small; cirrus and metraterm having spines internally; and eggs operculate. He described the excretory vesicle as a wide tube extending to the posterior testis, which I failed to confirm in lot 1.

Bykhovskaya and Kulakova [22] listed *Macroderoides asiaticus* [21] from *Pseudobagrus fulvidraco* of Primorye, USSR, as a synonym of *O. pseudobagri.* I agree to this treatment because this fluke [21] has a large external seminal vesicle and is closely similar to *O. pseudobagri* in general morphology, final host and locality (see below). *O. siluri* was synonymized with *O. pseudobagri* by Fischthal and Kuntz [6], whom Ejsymont [19] followed. It seems to me, however, that *O. siluri* [12] is different from *O. pseudobagri* in the oral and the ventral sucker being subequal in size, the unarmed cirrus and metraterm and the vitellaria commencing at the posterior border of the ventral sucker. The trematode that Ejsymont [19] reported as *O. pseudobagri* from Poland more closely resembles *O. siluri* than *O. pseudobagri.*

This species has been recorded from *Pelteobagrus nudiceps* and *Silurus lithophilus* of Shiga Prefecture, Japan [16, this paper]; *Parasilurus* [=*Silurus*] *asotus, Percottus glehni* and *Pseudobagrus fulvidraco* of Primorye, USSR [9, 21, 23–25]; and *P. fulvidraco* of Fujian, China [26]. Besprozvannykh [9] and Ermolenko and Besprozvannykh [25] made experimental and field studies of its life cycle in Primorye, USSR. Xiphidiocercariae [or armatae cercariae] are formed in daughter sporocysts in the first intermediate host, *Lymnaea peregra amurensis.* Metacercariae encyst in several species of fishes and mollusks. The final host is *Percottus glehni.* Other final hosts there are *Parasilurus* [= *Silurus*] *asotus* and *Pseudobagrus fulvidraco* [21, 23, 24].

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